XXIII. *An Account of the Obſervations of the Tranſit of* Venus *and of the Eclipſe of the* Sun, *made at* Shirburn Caſtle *and at* Oxford. *By the Reverend* Thomas Hornſby, *M. A. F. R. S. and* Savilian *Profeſſor of Aſtronomy in the Univerſity of* Oxford.

Read June 15, 1769. THE weather, on the morning of the 3d of June, was ſo very unfavourable, both at the obſervatory of the Earl of Macclesfield and alſo here at Oxford, that there was very little reaſon to expect that we ſhould be able to make any obſervation. But here, a few minutes before noon, the clouds began to break, and I was enabled to obſerve the tranſit of the Sun's conſequent limb over the meridian. At one o'clock in the afternoon, the ſky was again overcaſt, and it rained for ſome time; but towards three o'clock, the clouds were diſperſed, the Sun ſhone out clearly, and at five o'clock there was hardly a cloud to be ſeen. The preceding evening was alſo ſo very favourable, that the ſeveral perſons who propoſed to make obſervations of the tranſit, had an opportunity of adjuſting their inſtruments.

The Right Honourable the Earl of Macclesfield made uſe of an excellent refracting teleſcope of $3\frac{1}{2}$ feet,

feet, made by Mr. Dollond, with a treble object-glaſs, magnifying 150 times; and at $7^h\ 7'\ 49''\frac{1}{2}$ apparent time, was certain that the planet had ſenſibly advanced upon the Sun's diſk, having ſeen a ſmall impreſſion upon the zenith part of the Sun's limb near a minute ſooner. At $7^h\ 23'\ 13''$ mean time, or $7^h\ 25'\ 28''\frac{3}{4}$ apparent time (as reduced from ſidereal time), his Lordſhip determined the internal contact, which he judged to happen when the dark penumbra, which was ſo ſenſibly perceived between the limbs of the Sun and Planet, was loſt upon the completion of the thread of light. His Lordſhip obſerved at a ſmall diſtance from the obſervatory, by means of a ſtop-watch, which was let go at the inſtant he judged the total ingreſs to happen, and immediately compared with the obſervatory clock.

Mr. Bartlett, a very excellent obſerver, who has been conſtantly employed in the obſervatory for many years, obſerved with a 14 feet refractor on the north ſide of the obſervatory, within hearing of the clock, the ſeconds of which were counted by Mr. Phelps, the other aſſiſtant obſerver. At $7^h\ 7'\ 4''$ apparent time, Mr. Bartlett firſt ſaw Venus upon the Sun; and at $7^h\ 23'\ 10''\frac{1}{2}$ mean time, or $7^h\ 25'\ 26''$ apparent time, he judged the ingreſs to happen, the teleſcope magnifying near 60 times.

Lady Macclesfield was alſo pleaſed to attend to the obſervation; and at $7^h\ 25'\ 16''\frac{1}{2}$ apparent time, judged the ſecond internal contact to happen, with a refracting teleſcope of 6 feet, through which the penumbra before mentioned was hardly to be diſtinguiſhed.

The

The ſky, though free from clouds, was charged with vapour, which occaſioned a conſtant undulation of the limbs of the Sun and Planet; and the wind ſometimes blew ſo hard as to incommode the obſervers.

On the next morning the ſky was very favourable to obſervation, and Mr. Phelps determined the eclipſe of the Sun to begin at $18^h\ 32'\ 45'',7$ mean time, or $18^h\ 34'\ 56'',7$ apparent time, and to end at $20^h\ 17'\ 23'',5$ mean time, or $20^h\ 19'\ 33'',8$ apparent time. The Earl of Macclesfield obſerved the end to happen one ſecond later, making uſe of Mr. Dollond's refractor.

The latitude of the obſervatory at Shirburn Caſtle is $51°\ 39'\ 22''$, as determined by obſervations of the Pole Star, at ſeveral different times; and is $3'\ 57''$ of time weſt of Greenwich, and $1'\ 6''$ to the eaſt of Oxford, as appears by computing the difference of meridians between Mr. Short's houſe, Shirburn Caſtle, and Oxford, as they reſult from the obſervations of the Sun's eclipſe on April 1, 1764.

I propoſed to obſerve the tranſit of Venus and the Sun's eclipſe in the upper room of the tower of the Schools, which, though the floor of it be very unſteady, yet from its elevated ſituation afforded me the cleareſt view of the north-weſt part of the horizon, and is indeed the beſt place for making occaſional obſervations in different parts of the heavens, and at different altitudes, which this place at preſent affords. The clock, furniſhed with a compound pendulum, was for ſome time carefully compared with another clock

clock of the ſame conſtruction, which is fixed in a ſmall obſervatory in the houſe where I live, and which I had altered from ſidereal to mean ſolar time, for the eaſier compariſon of thoſe clocks, which ſeveral gentlemen had procured, in order to obſerve this rare and curious phænomenon. The time was determined by meridional tranſits of the Sun, taken with a tranſit inſtrument made by Mr. Bird, and placed very exactly in the plane of the meridian, the focal length of the object-glaſs being 43 inches. The motion of both clocks was perfectly even and regular.

The atmoſphere was ſo loaded with vapour, and the limb of the Sun was in ſuch a conſtant ſtate of undulation, that I determined to obſerve the external contact with a refractor of 12 feet, furniſhed with a ſyſtem of eye-glaſſes, and magnifying 68 times. I had found, by a previous computation, that the Planet would make the firſt impreſſion upon the Sun's upper limb, about nineteen minutes of a degree to the right hand of a vertical circle paſſing through the Sun's center. I therefore kept my eye conſtantly fixed upon that part, and at $7^h\ 5'\ 58''$ apparent time, I perceived that a ſmall part of the Planet's diameter had certainly entered upon the Sun's diſk; the impreſſion, which I had obſerved for a few ſeconds before, having continued upon that part. While the Planet was paſſing over the Sun's edge, I determined, with the old micrometer applied to the 12 feet glaſs, the following differences of declination between the northern limb of the Sun, and the ſouthern limb of Venus, with as much accuracy as the unſteadineſs of the floor would permit.

Mean

	Mean Time.				
	h	′	″		
At	7	8	48	3	35,2
	7	11	37	3	44,5
	7	13	28	3	46,4
	7	14	57	3	50,1
	7	15	42	3	53,6

But as the time of the internal contact began to draw nigh, I directed a refractor of $7\frac{1}{2}$ feet, with a double object-glass, to the Sun, made by Mr. Dollond, and magnifying 90 times; and soon after $7^h\ 21'$ mean time, perceived that the Planet appeared to be wholly entered upon the Sun, though the limbs of the Sun and Venus were not actually separated; that part of the Sun's edge, where the ingress happened, being very sensibly obscured by a penumbra, and the limbs appearing to be united, by a kind of ligament of a considerable breadth. This ligament became narrower and narrower, and was at length reduced to a point, and actually broken at $7^h\ 21'\ 57''\frac{1}{2}$ mean time, or $7^h\ 24'\ 13''\frac{1}{4}$ apparent time. At $7^h\ 24'\ 23''$ apparent time, the thread of light between the edges of the Sun and Venus, which was before compleated, now appeared to me of a very sensible breadth, and to equal $\frac{1}{10}$th of the Planet's diameter. If I have estimated this breadth properly, the true internal contact must have happened considerably more than a minute sooner. The Swedish astronomers have described this appearance very nearly as I saw it; but according to the ac-

count * given by Mr. Mallet, the interval of time between the true and apparent ingreſs, when the limbs appeared perfectly to coincide, and when the ligament was obſerved to be broken, did not exceed 53″, according to Mr. Melander's obſervation, and amounted to 56″, according to Mr. Wargentin. This appearance, in all probability, is occaſioned by the refraction which the rays of the Sun ſuffered in paſſing through the high and denſe atmoſphere of the Planet, and was perhaps rendered more ſenſible by the vapours near the horizon; as a ſimilar appearance was obſerved at the ſecond internal contact, in 1761, at very conſiderable altitudes, though in a ſmaller degree. But it will, I fear, occaſion a much greater uncertainty in the quantity of the Sun's parallax deducible from theſe obſervations, than was reaſonably expected.

By a mean of ſix obſervations, I found the Planet's diameter $=58'',1$; being not greater than $59'',0$ from four of the obſervations, all agreeing preciſely to the ſame part of a ſecond; nor leſs than $56'',9$ by the leaſt of the other two.

About fifteen minutes after the internal contact, a very thick and black cloud, which moved towards the eaſt, with a ſlow motion, along the ſkirts of the horizon, prevented any further obſervations.

The next morning, the ſky being perfectly clear, and the limb of the Sun undulating but in a ſmall degree, I made the following obſervations of the Sun's eclipſe.

* Phil. Tranſ. 1766, p. 77.

App. Time. h	′	″			
At 18	33	45	Beginning of the eclipſe.		
	36	4	The double ſpot (*a*) immerges.		
	36	15	covered.		
	46	circ.	A large irregularity on the Moon's edge appeared on the Sun's diſk.		
	54	44	The Moon touches the hazineſs ſurrounding the largeſt ſpot (*b*).		
	55	15	Nucleus of the ſpot (*b*) immerges.		
	56	11	D° covered.		
18	57	7	Hazineſs of (*b*) covered.		
19	5	12	The Moon touches the hazineſs ſurrounding the ſpot (*c*).		
	6	14	The nucleus immerges.		
	6	38	covered.		
	8	14	The ſpot (*d*) covered.		
	10	14	The ſpot (*f*) covered.		
	10	28	The ſpot (*g*) covered.		
	16	8	The ſpot (*h*) immerges.		
19	16	32	The ſpot (*h*) covered.	′	″
19	17	51	Lucid parts meaſured	15	15,7
	18	37		15	12,7
	19	11		15	9,5
	19	58		15	1,5
	20	52		14	53,0
	21	28		14	49,7
	22	12		14	44,5
	22	48		14	41,3
	23	38		14	40,4
	24	28		14	39,5

App.

App. Time. h	′	″		′	″
At	25	8		14	44,6
	25	44		14	48,3
	26	31		14	49,8
	27	19		14	50,5
	28	19		14	54,5
	28	58		14	59,1
	29	38		15	1,9
	30	15		15	4,7
19	52	37	The ſpot (*c*) totally uncovered.		
	55	17	(*b*) begins to emerge.		
	55	39	(*b*) totally uncovered.		
20	15	30	(*i*) totally uncovered.		
20	18	36	Eclipſe nearly ended.		
20	18	42½	Eclipſe ends.		

The ſpots are marked with letters in the order in which they were covered by the Moon.

Many irregularities were obſervable upon the Moon's limb; though none of them were ſo pointed as ſome which I obſerved in the eclipſe of the Sun, on Auguſt 16, 1765.

Towards the end of the eclipſe, the ſky began to be hazy; which hazineſs increaſed, and was very conſiderable at ten o'clock in the morning.

On the top of New College Tower, the Reverend Mr. Lucas, Fellow of New College, with an excellent acromatic teleſcope of 6 feet, magnifying 60 times, was certain that the external contact of Ve-

nus with the Sun was paſſed at 7^h 6′ 12″ apparent time, having perceived a ſmall impreſſion upon the Sun's edge ſeveral ſeconds ſooner; and the Reverend Mr. Clare, Fellow of St. John's College, with the ſame inſtrument, judged the thread of light to be completed at 7^h 24′ 28″, having obſerved the limbs to be in contact ſeveral ſeconds ſooner.

The next morning Mr. Lucas obſerved the beginning of the Sun's eclipſe at 18^h 33′ 47″, and the end at 20^h 18′ 37″.

Mr. Sykes, of Brazen Noſe College, with an acromatic refractor of $3\frac{1}{2}$ feet, made by Mr. Dollond, firſt ſaw Venus upon the Sun at 7^h 6′ 0″, and obſerved the thread of light to be completed at 7^h 24′ 22″.

Mr. Shuckburgh, of Balliol College, obſerved there the external contact of Venus with the Sun at 7^h 6′ 8″ apparent time, and the internal contact at 7^h 24′ 25″; though at 7^h 23′ 16″, he judged that the center of the Planet was removed more than its own ſemidiameter from the Sun's limb, or that the true internal contact was then actually paſt. He is of opinion that the obſervation of the completion of the thread of light could not be made nearer than to 8″ or 10″, on account of the undulation of the limbs: and he farther adds, that when Venus was wholly entered upon the Sun, he could no longer perceive the penumbra that attended the Planet before the apparent contact; but that in the room of it there appeared a ſmall circle of light, ſomewhat more luminous than the ſurrounding parts of the Sun. Mr. Shuckburgh alſo obſerved the beginning of the eclipſe at 18^h 33′ 51″,

and the end at $20^h\ 18'\ 38''$, with the appulſe of the Moon to ſeveral of the ſpots.

In an unfurniſhed room of the Hoſpital, that commanded the north-weſt part of the horizon, Mr. Nikitin of St. Mary Hall, and inſpector of the Ruſſian gentlemen ſent here for their education by the Empreſs of Ruſſia, and Mr. Williamſon, of St. Alban Hall, both well verſed in the Mathematics, made the following obſervations of the tranſit, with a reflector of 10 inches, and a refractor of 8 feet:

	1ſt ext. cont.			Ingreſs.		
	h	′	″	h	′	″
Mr. Nikitin	7	6	44	7	24	$15\frac{1}{2}$
Mr. Williamſon	7	6	29	7	24	$10\frac{1}{2}$

The tranſit and the eclipſe were alſo obſerved here by the Reverend Mr. Horſley, F. R. S. and Mr. Cyril Jackſon, A. B. and ſtudent of Chriſt Church. But as Mr. Horſley propoſes to lay the obſervations before the Society, I have only to add, that I believe them to have been made with all the accuracy and care that the circumſtances of the time and place would permit; and that thoſe gentlemen are not leſs diſtinguiſhed by their zeal for aſtronomical and mathematical inquiry, than for their extenſive knowledge and erudition.

The latitude of Oxford is $51^\circ\ 45'\ 15''$, as determined by myſelf, from ſeveral obſervations of the Pole Star, both above and below the Pole, with an excellent mural quadrant, of 32 inches, made by Mr. Bird; the focal length of the teleſcope being 34 inches.

34 inches. I am the rather induced at preſent to mention this, as the latitude of Oxford, given by Mr. De la Lande in the *Connoiſſance des Temps*, and attributed to me, was determined by the late Profeſſor Bliſs, from obſervations made with a ſmaller and leſs perfect inſtrument. The longitude of Oxford is $5' 3''$ or $5' 4''$ to the weſt of Greenwich, the former quantity being deduced frow a compariſon of the Sun's eclipſe, obſerved by myſelf, with Mr. Short's obſervation, an allowance being made in the computation for the figure of the earth, in the effect of the Moon's parallax.

Oxford, June 14, 1769.

Thomas Hornsby.